# BUSINESS INTELLIGENCE FOR HUMAN RESOURCES:

## TOWARD A NEW PARADIGM FOR REPORT DEVELOPMENT AND DELIVERY

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# TABLE OF CONTENTS

# OVERVIEW

As a corporate workforce grows, managers need more information close at hand to make decisions for the company. As every scientist knows, we can't judge, let alone improve, something that can't be measured. Thus, firms that are committed to constant improvement generate reports on various business metrics in order to make informed decisions. Sandia National Labs is no exception. Enterprise business intelligence (BI) is very important to keep such a large organization on the right track, as it signals any adjustments that may be required to stay the course. Like teams in other fields, Sandia's HR Reporting wants to provide the most valuable Workforce BI possible, and it is considering a change in reporting paradigm to achieve that.

## CLIENT ORGANIZATION

Established in 1948, Sandia National Laboratories (SNL) provides national security and multidisciplinary engineering services to help the United States government address complex threats and keep the country's nuclear stockpile safe, secure, and effective.[v]  As a multidisciplinary national laboratory and federally funded research and development center (FFRDC), Sandia accomplishes tasks that are integral to the mission and operation of its sponsoring agencies by:[vi]

- anticipating and resolving emerging national security challenges
- innovating and discovering new technologies to strengthen the nation's technological superiority
- creating value through products and services that solve important national security challenges
- informing the national debate where technology policy is critical to preserving security and freedom throughout the world

The Laboratory is operated and managed by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin. Sandia Corporation operates Sandia National Laboratories as a contractor for the U.S. Department of Energy's National Nuclear Security Administration (NNSA) and supports numerous federal, state, and local government agencies, companies, and organizations.[vii]

Within SNL, the Chief Information Office is dedicated to information technology services. This division, 09000, provides Sandia's information management infrastructure, including corporate information systems and applications, network and telecommunications structure, science and engineering information systems, and cyber security operations.[viii]  Within the range of IT services, Center 09500 focuses on information solutions and services (ISS), such as production information systems and software applications. ISS developers ensure that these products integrate with line and business processes to facilitate the delivery of effective national security technologies.[ix]  At a more specialized level, Enterprise Information Systems, Group 09540, includes software engineering, system architecture, and business intelligence (BI). This document concerns a project undertaken at

the departmental level. Within Organization 09544, HR Systems, the HR Reporting team maintains the HR Queries system and develops HR reports used throughout the Labs.

## PROBLEM

The HR Reporting team currently uses Microsoft Access as a front-end interface to its multiple SQL Server databases. When developers run a report, the results are typically exported to a MS Excel spreadsheet or pdf, then e-mailed to each of a number of people throughout the Labs who require that report. The LAN-Based Reporting System (LaRS) distributes monthly production reports to all recipients automatically, and *ad-hoc* reports to the requestors as needed. However, customers desire reports to be generated on-demand with variable parameters at a moment's notice. This could be achieved with a more robust self-service reporting web site, since it would deliver semi-custom reports without the help of a developer. Unfortunately, MS Access is not a viable engine to generate and publish reports on the web because the *web* databases of Access Services are not capable of synching with external data (*e.g.* the HR data hosted by SQL Server). The HR Reporting team wants to develop a proof of concept to add Microsoft Business Intelligence to the HR self-service reporting system that enables the users to pivot their data and run different scenarios based on business needs.

## OBJECTIVES

The HR Reporting team has recognized a need to revise its system for delivering business intelligence to provide more robust user functionality. This document is intended to outline a new approach to BI production and distribution using the Microsoft BI stack, proving the utility of the suite for HR Reporting. The use of these tools would leverage software that users already have (e.g. MS Excel), and provide the analytical convenience of PowerPivot. The new methodology was developed while addressing questions regarding the efficiency of Sandia's efforts to recruit talent on college campuses. The primary question, "What is the recruiting cost per student or graduate that we hire from identified schools?" prompted the first-time integration of a subset of financial data into the human resources database. We will track the development of the new methodology via the steps required to answer that question.

## SCOPE

This document addresses only the methodology recommended for reporting on human resources data, which is limited to the HR reporting database. It is written for use with Microsoft SQL Server, and does not apply to other database management systems, such as Oracle or MySQL. The work product created in the course of this research/discovery/endeavor is to be considered a proof of concept only. It was not initiated using the accepted process for ad-hoc reports, and its design was not reviewed for conformance to standards observed for official HR reports. The report has not entered production.

## TARGET AUDIENCE

This document is intended for three audiences and three purposes:

- The developers on the HR Reporting team, as introduction to the publication and deployment of Microsoft Business Intelligence web-ready reports
- The management of the HR Systems department, as a record of the reasoning and decisions that guided development of the proposed protocol
- The academic advisor(s) of the author, as a deliverable demonstrating the outcome of an internship in the business intelligence (BI) field

The most important of these are the developers of the HR Reporting team itself. The team comprises software systems engineers, software engineering technologists, and a business systems analyst, some of whom are most comfortable within the user interface of MS Access and others who interact with the data primarily via SQL code. Software systems engineers are responsible for organizing data in the most effective way, programming the database to securely perform any automated tasks, and instituting a data-warehouse to eventually replace the existing HR database. Technologists and analysts run and maintain widely distributed production reports and create ad-hoc reports to customer specifications as requested.

## REQUIREMENTS

Any methodology employed for HR reporting must generate reports with accuracy, precision, readability, versatility, and speed equal to or better than that of the current system. In order to constitute a viable option, the solution must:

1. enable web-based delivery over Sandia's intranet
2. accept custom parameters by which to filter the results of common reports
3. feature formatting options sufficient to meet customers' aesthetic expectations
4. permit easy export of report results to MS Excel or text format
5. deliver on-demand reports within sub-second execution
6. allow the administrator to control access to each report at the user name level
7. impose only a moderate learning curve on report developers

## USE CASES

A typical use case for the new reporting protocol is a new request for an ad-hoc report to be delivered online. With an understanding of the customer's specifications, a developer builds the report for SQL Server Reporting Services using MS Visual Studio (aka SQL Server Data Tools) as a design platform. The SSRS report is then

deployed to a secured SharePoint website. Users can view the report online as well as export it to MS Excel or use it for further processing via PowerPivot (a feature of Excel 2010 and higher). Using Excel charts, the imported data can be expressed by a variety of complex visualizations.

The same steps are involved in the deployment of production reports. Due to their widespread use, certain production reports could also be programmed to elicit parameters from the end-user for greater customization and precision.

## DESIGN IMPLICATIONS

The report deployed for demonstration purposes involves financial cost information as well as human resources data. This is found in the Financial Reporting Services (FRS) data warehouse, rather than the HR database. In order to calculate the desired metric, cost per hire, the relevant table[1] must be imported weekly from FRS to the HR database, which requires the permission and the assistance of Sandia's enterprise database administrators.

Also, the meanings of the *Project* and *Task* codes change from year to year. That means the ever-changing codes must be captured in a newly created junction table[1] that links them to a description applicable to a specific range of dates.

## ASSUMPTIONS AND CONSTRAINTS

A couple of assumptions informed the query logic for building the test report. One, the projects and tasks corresponding to specific schools will not change more often than once per year. Two, the schools' ranking and status as an *executive*, *corporate*, or *key* school will not change more than once per year. Also, the costs attributed to each project and task will increase weekly.

## INSTITUTIONAL KNOWLEDGE

Sandia's Financial Reporting Services (FRS) team had overhauled its own reporting system. FRS went from a "BI solution based on SAP Business Objects 6.5[1]"[x] to the applied combination of SQL Server Analysis Services (SSAS) and Reporting Services (SSRS). The upgrade allowed them to generate the same volume of weekly reports in significantly less time, automate a number of maintenance tasks, and streamline security by linking authorization to Active Directory.[2] The input of FRS solutions architects was invaluable in devising a reporting architecture that

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[1] SAP is a powerful software package for enterprise business intelligence and reporting.

[2] This even became the subject of a Microsoft case study available here: http://www.microsoft.com/casestudies/Microsoft-SQL-Server-2012-Enterprise/Sandia-National-Laboratories/Laboratory-Speeds-Reporting-by-99-Percent-Simplifies-IT-and-Saves-250-000-Annually/710000001484

works efficiently for HR Reporting, not to mention their help in troubleshooting the implementation and deployment of prototype reports.

# DESIGN SPECIFICATIONS

Although HR Reporting has scores of production reports, it was decided to "kill two birds with one stone" by developing a new report with which to try out approaches to the MSBI delivery. This gave us an opportunity to create value for the HR customer in the process.

## ASKING THE RIGHT QUESTION

The first step in developing the Cost-per-Hire report was to identify the variables that are necessary to calculate that metric with the desired granularity. In addition to Sandia's cost to successfully recruit candidates, the customer wished to isolate these costs by fiscal year and by school, as well as note the proportion of new hires who received regular positions, as opposed to temporary positions such as student internships. This means that, for each applicant, we needed to know the school, graduation date,[3] and start date if applicable. For each position filled, we needed to know its regular vs. temporary status. For each school, we needed to know the ranking[4] and the project and task charged when recruiting on its campus. Finally, for each project and task, we needed to know the amount charged and fiscal year the charges accrued.

Two components of this knowledge were outside the purview of the HR Reporting team. Our customer provided a list of actively recruited schools along with the projects and tasks associated with campus visits there. The FRS team provided the costs racked up to each project and task by fiscal year. Being that the costs would increase weekly, a stored procedure was put in place to import and overwrite the associated table every Saturday. A new table was created for the association of school to project and task. Since these are expected to change annually or less frequently, those updates will be manual and occur no more than once per year.

Several steps were involved in isolating the relevant information. We composed views of data from existing tables and views, which served as intermediate data sources for queries eventually resulting in the "Cost per Hire" data set. (Query logic available subject to approval by official Sandia reviewers.) The final data set became the content of the HR Reporting team's first SSRS report. In addition to the cost per hire, the report included indicators of four special school classifications used by Sandia: *Top 25*, *Key Schools*, *Executive* linkages, and *Corporate* linkages. It also provided the number of applications received, interviews scheduled, and hires originating from each school.

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[3] Graduation date is important to ensure that the student who applied had a reasonable chance of coming in contact with a recruiter during Sandia's campus visit. To be considered "recruited," a student must have applied before or within three years of his/her graduation date.

[4] Rankings are taken from the "Best Engineering Schools" published annually by *US News & World Report*.

## DISTRIBUTING AND USING THE ANSWER

The HR Reporting team looked to the FRS team for advice on the most sensible naming conventions, the most efficient approach to hosting, the most logical architecture for a reporting "farm," and the most convenient vehicle for delivery to Lab-wide customers.

In the interest of centralizing reporting on company operations, SNL has established a SharePoint portal dedicated to enterprise business intelligence (EBI). A human resources category was added and an HR BI sub-site carved out of the shared reporting server. Inspired by FRS practices and knowing that this will be the first of many SSRS-born HR reports, we created dedicated folders on the server for data sets, data sources, and report elements. We configured the report to overwrite its data set and data source with every deployment. Although it is possible to embed both data sources (*e.g.* a database connection) and data sets (*i.e.* the results of a data query), the best practice is to establish shared data sources and shared data sets so that these can be reused in future reports on the same server.

Upon test deployment, a link to the so-named "Recruiting Efficiency Report" appears within the human resources section of the BI portal. With the click of a link, the report opens with SharePoint's built-in viewer, which also offers users the ability to export the content in seven standard formats or a dynamic data feed. Users may also subscribe to alerts of new data in the report, and, with the appropriate permissions, even edit the report design in the web-based Report Builder tool. Although all of these methods of delivery provide the same information, one is especially convenient and powerful: the dynamic data feed. The action to export a data feed generates an Atom[5] service document file (*i.e.* <ReportName>.atomsvc), which defines how a local document (*e.g.* MS Excel workbook) should reach a data source (*e.g.* a hosted SSRS report). When opened, the Atom service document file launches Excel's Table Import Wizard, prepopulated with the configuration details necessary to bring the report contents into the PowerPivot module of a new or existing workbook, which can then be refreshed any time without leaving Excel. The PowerPivot data source can be used in conventional charts, but its natural complements are PivotTables and PivotCharts. The combination of these is arguably the most seamless solution that allows advanced custom visualizations (via Excel) of data that gets updated frequently (via SSRS). Such visualizations could be developed by the end-users personally or commissioned from the HR Reporting team as an extension to the original report.

Although we have made reference to the "deployment" of one report, this should not be confused with the deployment of the new reporting practice. Although it was shown to the customer to demonstrate what is possible, the "Recruiting Efficiency Report" is not a production-ready report.

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[5]  Atom Syndication Format is an XML standard used for web feeds. Comparable to RSS, it is used to share headlines, text, and metadata of blogs and other periodically updated online publications, as well as SSRS output.

## TESTING

The solution was subjected to a peer review that brought up some possible changes to the prescribed design. Both the numerical results and a sample set of visualizations made in Excel were displayed within a web browser. The reviewers suggested some experimentation with sample data to observe the results of the query in various circumstances, e.g. if a top-25 school were to drop out of the rankings entirely. The majority of suggestions were superficial in nature, such as the wording of labels and color of data points. It was also reviewed by the HR customer to determine the fit for the business need.

## FUTURE ENHANCEMENTS

To make the proof of concept report most useful to the customer, it may be updated with parameters for several variables. This will allow the user to specify a time frame of interest, among other things. The report would then solicit parameter values from the user upon execution.

## PROCESS & SCHEDULE

| Stage | Activity | Date |
|---|---|---|
| Planning | • Determine software tools needed for each stage of development<br>• Study organization of data within HR database<br>• Identify data required to answer customer's question<br><br>***Milestone #1***  Review HR data structures with subject matter experts to confirm applicability of chosen fields | June 30 |
| Query Development | • Begin weekly imports of FRS data into HR database<br>• Create junction table to associate schools with projects, tasks<br>• Create view to retrieve records of applicants, jobs they applied for, schools they attended, and costs of recruiting at those schools<br>• Query view to obtain per-school number of applicants, interviewees, and hires, and finally, the cost of recruiting per student hired<br>• Optimize queries to shorten processing time<br><br>***Milestone #2***  Check calculated numbers against data in use by business systems analyst to confirm accuracy of query logic | July 25 |
| Visualization Development | • Manually import query results into MS Excel<br>• Build Pivot Tables and Pivot Charts to graphically represent aspects of data<br><br>***Milestone #3***  Demonstrate use of Pivot Tables and Charts to customer and collect feedback re: functionality | August 22 |
| Report Development | • Using SQL Server Reporting Services, replicate query solution<br>• Research best practices for secure SSRS delivery to end users<br>• Set up HR BI sub-site of SNL's EBI portal<br>• Create dedicated locations w/in sub-site for data sets, sources, and reports<br>• Configure SSRS project for appropriate target URLs<br><br>***Milestone #4***  Deploy test SSRS report to HR BI sub-site, share with team | Sept 26 |
| Implement Dynamic BI | • Export report contents as data feed<br>• Open data feed as PowerPivot module in blank Excel workbook<br>• Build Pivot Tables and Charts using PowerPivot module as data source<br><br>***Milestone #5***  Provide PowerPivot-enhanced Excel workbook to customer and demonstrate how to refresh and filter data | Oct 31 |
| Future Enhancements | • Program SSRS report to solicit parameters upon execution<br>• Revise and make PowerPivot-enhanced Excel workbook available for download at HR BI sub-site | TBD |

## PLATFORMS SUPPORTED

A Windows PC is required to develop for SSRS. Fortunately, no member of the HR Reporting team is without one, since this is also true of MS Access, the current reporting environment. The development platform should be equipped with MS SQL Server, including Reporting Services, and MS Visual Studio (which can also be included in the SQL Server installation). The lighter weight Report Builder is also a PC-only tool. End-users can export the report or view it online via SharePoint whether running Windows or Mac OS X 10.6 and up. However, the PowerPivot data feed option is only available to those using MS Office 2010 (and up) for Windows, not Mac.

## PROCESS REFINEMENTS

If the SSRS/web-delivery protocol is adopted for HR Reporting, the tables, views, queries, stored procedures, and ultimately report that were created in the course of this project will be subject to the team's standard three-stage promotion process and software delivery lifecycle. Database objects begin life on the Development database server, move up to the Quality server when complete, then graduate to the Production server if they are demonstrated to be "ready for prime time." Similarly, SSRS reports will be deployed first to the HR BI Development server where they are unit tested and moved up to the HR BI Quality server if they do not break and there tested by the customer who approves for final delivery. When new SSRS reports are demonstrated to display and export properly in all formats and browsers, they will be reviewed for standard formatting and branded presentation. Reports are finalized by deploying them to the main HR BI server, where they are available to customers. This process is documented in a step-by-step tutorial available on the HR Reporting team's SharePoint web site.

## DEVELOPER TRAINING

Should the SSRS/web-delivery protocol be adopted, it will come with a learning curve. About half of the HR Reporting team are involved in the design of reports, and they must begin designing for SSRS using Visual Studio instead of Access. It is recommended that the designers follow a series of free online tutorials on developing for SSRS. That will not necessarily prepare them to accomplish the advanced designs they produced in Access. The relevant team members should also attend a class in SSRS development if budget permits. The transition will be moderately painful, but the experience of the FRS team demonstrates that it is very much worth the effort.

## RESULTS

This project has successfully proven out the MSBI technical stack as a viable new self-service option for HR Reporting. Many of the end users are capable of using PowerPivot and like the ability to pivot the data based on their business needs.

## COSTS

Sandia National Labs already has licenses for SQL Server Reporting Services, so there will be no costs for software from adopting the proposed protocol. The existing server(s) powering the EBI portal will be sufficient to deliver HR Reports as well as others that are already hosted there. Should this change be pursued, potential costs will be additional time spent bringing all report designers up to speed on SSRS development and prioritization within the scope of the existing work

# LESSONS LEARNED

This project was led by a solutions architect who manages several different projects. A project manager is the best source for high-level requirements, but not necessarily knowledgeable about the HR Reporting domain. Nonetheless, the author took direction primarily from the project manager for the majority of the performance period. The team's software systems engineers and senior technologist would have been a better source of guidance in terms of how best to extract the desired information and develop the deliverable.

Much trial and error was involved in extracting the desired information for the pilot report. Initial queries had extremely long processing times, along the lines of 10 minutes. Since that would never be acceptable to a customer, we sought ways to optimize the query so that it performed faster. The solution ultimately was to denormalize a specific set of data such that the majority of processing took place before executing the query.

## PERSONAL REFLECTIONS

The author found MS OneNote to be a valuable tool for documenting the relationships between tables and views and the hierarchy of queries used to narrow down a data set. OneNote preserves the color coding of SQL written in SSMS and encapsulates the length of a query or create statement in a text box that can be dragged and dropped. In that form, the various written expressions could be arranged to show how each database object fed into the next, culminating in the query that produced the final data set. OneNote also permits hand-drawing on the canvas of lines that link the objects together. This provided a very intuitive representation of the progression of query logic necessary to answer the question.

# CONCLUSION

SQL Server Reporting Services can indeed provide a suitable replacement for MS Access as a reporting environment. It will allow the HR Reporting team to serve up a more effective self-service model that allows customers to pivot on demand to meet their business needs.

[i] http://info.sandia.gov/recruiting/about.html

[ii] http://info.sandia.gov/recruiting/strategy/who_we_recruit.html

[iii] http://info.sandia.gov/recruiting/strategy/where_we_recruit.html

[iv] http://info.sandia.gov/recruiting/strategy/how_we_find_top_recruits.html

[v] http://www.microsoft.com/casestudies/Microsoft-SQL-Server-2012-Enterprise/Sandia-National-Laboratories/Laboratory-Speeds-Reporting-by-99-Percent-Simplifies-IT-and-Saves-250-000-Annually/710000001484

[vi] http://www.sandia.gov/about/mission/index.html

[vii] http://www.sandia.gov/about/index.html

[viii] http://info.sandia.gov/smm/who-does-what.html

[ix] https://sharepoint.sandia.gov/sites/ISS/Pages/default.aspx

[x] http://www.microsoft.com/casestudies/Microsoft-SQL-Server-2012-Enterprise/Sandia-National-Laboratories/Laboratory-Speeds-Reporting-by-99-Percent-Simplifies-IT-and-Saves-250-000-Annually/710000001484